section 13

CD V-720-3

specifications:

- Ranges: 0-5, 0-50, 0-500 r/hr
- Sensing Element: Ionization Chamber
- Accuracy: ±15% of true dose rate from cobalt 60 gamma radiation
- Batteries: Two 1-1/2 volt NEDA 13
  One 22-1/2 volt NEDA 215
- Dimensions: approx. 9" long x 4-1/2" wide x 6-1/2" high including handle
- Weight: approx. 4-1/2 lbs. including batteries

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GENERAL DESCRIPTION

Introduction

The Landers, Frary & Clark CD V-720 model 3 is a portable ionization chamber instrument designed for the detection of high levels of beta and gamma radiation. The ionization chamber is located inside the case in the lower front portion of the instrument. The entire instrument and its accessories include an indicating meter, ionization chamber, and carrying strap. The bottom of the instrument case contains a sliding beta shield to permit discrimination against beta particles if desired.

Meter and Controls

The CD V-720-3 uses a ruggedized, sealed meter to meet the instrument requirements for water-tightness, shock, and vibration resistance. Two controls are provided. One control is a range selector switch which turns the instrument on, checks its operation, and selects the proper sensing range. The other control is a zero control which is used to adjust the instrument to assure proper reading. Zeroing compensates for temperature variations and battery aging.

Adjustments and Readings

Zero Adjust

Turn the instrument on by turning the range switch from OFF to the ZERO position. Wait about a minute to allow the electrometer tube to warm up, then orient the ZERO control until the meter indicates zero. The instrument must be zeroed before attempting to check the circuitry or use any of the sensing ranges.

Circuit Check

Turn the range switch from the ZERO position to the CIRCUIT CHECK position. The range switch must be held against the stop in this position since the switch is spring-loaded to return to OFF. The meter should read in or above the red outlined section labeled CIRCUIT CHECK. Weak or dead batteries are often the cause of inability to zero or circuit check the instrument. Refer to the Trouble Shooting Guide for corrective measures if a low reading is obtained.

The zeroing and circuit check operations may be performed at any time whether the instrument is in a radiation field or not. However, the instrument must be zeroed before making the circuit check.

Sensing Ranges

The radiation sensing ranges are activated by turning the range switch to X100, X10, and X1. The sensing ranges can be checked only for erratic or upscale readings unless a radioactive source is available. In the absence of radiation, the meter should return to within 3 minor divisions of zero after allowing a few seconds for transient currents to dissipate.

Table 13-1 lists switch positions and the corresponding meter readings.

Switch Position	R/hr
X1	0-5
X10	0-50
X100	0-500

Table 13-1. Switch Positions vs Meter Readings

Figure 13-1 shows the meter face. Readings should not be taken with the pointer indicating in the lower 10% of the scale. Turn to the next most sensitive range until the pointer indicates in the upper 90% of the scale.

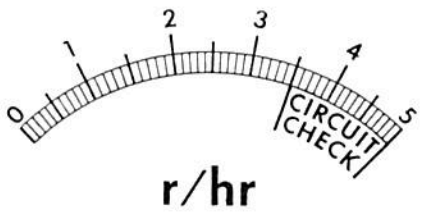


Figure 13-1. Meter Face

A sliding beta shield is provided at the bottom of the instrument to assist in determining the type of radiation being detected. The shutter has three positions:

1. Completely closed – gamma radiation sensitivity only.
2. 25% open – gamma and beta radiation.
3. Completely open – maximum sensitivity to beta radiation.

The beta shutter should be kept closed when the instrument is not in use to protect the beta window from damage.

Batteries

The CD V-720-3 is powered by two 1-1/2 volt "D" size batteries and one 22-1/2 volt "B" battery. The batteries will operate the instrument continuously for over 150 hours and much longer on an intermittent basis. Refer to Appendix A for acceptable types and makes of batteries.

Installation

1. Open the instrument by opening the pull catches at the ends of the case and lifting the case top straight up and out of the case bottom.
2. Remove the knurled nut from the threaded stud, and remove the battery hold down clamp.

3. Install the batteries according to figure 13-2.
4. Replace the battery hold down clamp over the three batteries and tighten the knurled nut.

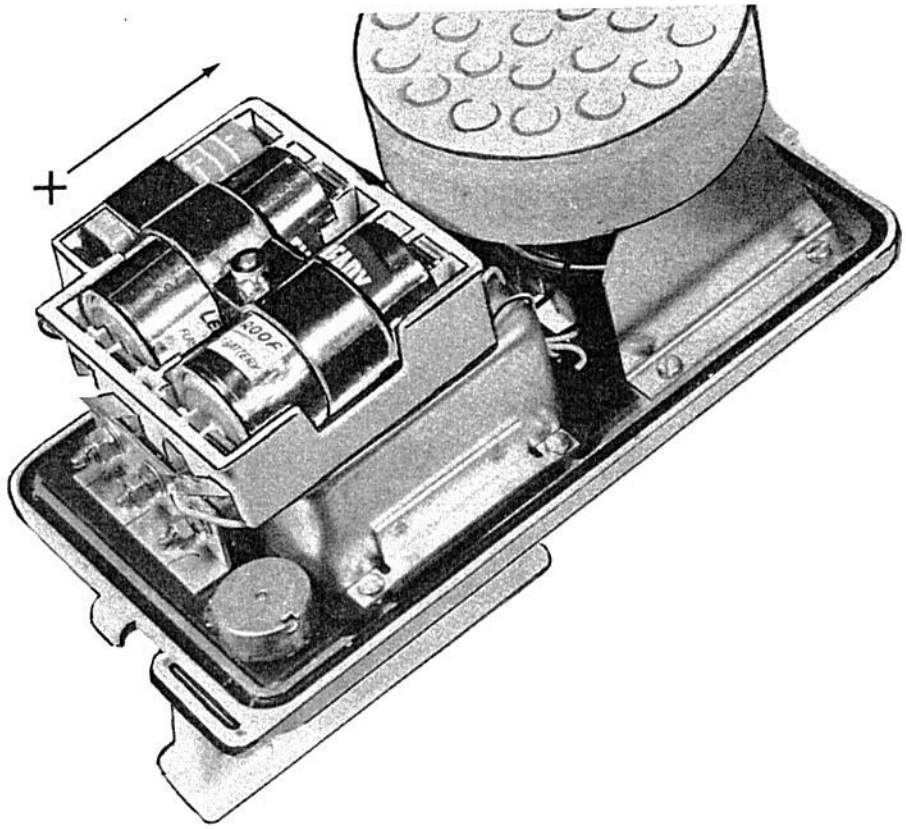


Figure 13-2. Battery Installation

Replacement

The batteries should always be checked before making further instrument adjustments or repairs. The batteries may be checked with a voltmeter while installed in the instrument. With the range switch in the ZERO position, the 1-1/2 volt batteries should read at least 1.25 volts and the 22-1/2 volt battery should read 19.5 volts or higher. The batteries may also be removed and checked with a battery tester.

Good batteries are required since a direct relationship exists between battery voltage and instrument response to radiation. Instruments with very weak batteries may give errors in radiation resonse even though satisfactory circuit check and zero adjustment may be obtained.

Electronic Circuitry

All electrical components which make up the circuitry are fastened to a printed circuit board. The circuitry serves to measure the minute current from the ionization chamber which indicates the presence of ionizing radiation. The high impedance components are housed in a light-tight enclosure for protection and shielding.

The current from the ionization chamber is amplified by an electrometer tube amplifier circuit utilizing a 5886 or VX-86 electrometer tube. With the range switch in the ZERO position the high megohm resistor is removed from the grid circuit so that no signal voltage can be developed as a result of any ionization chamber current. The plate current is balanced against the bucking current, and the resultant current through the meter is zero. The bucking current is obtained from the filament battery and is adjusted by means of the ZERO potentiometer, R-12.

When the range switch is placed in a range position, a high megohm resistor is inserted in the grid circuit. Current from the ionization chamber produces a positive signal voltage across this resistor which results in an increase in plate current. The resultant current through the meter is no longer zero, and the meter therefore measures the increase in plate current which is proportional to the radiation intensity. The range switch changes high megohm resistor values to keep the voltage applied to the electrometer tube grid within the proper operating range.

SERVICING

Precautions

High Impedance Circuitry

The high megohm resistors, electrometer tube, ceramic switch wafer, and chamber feed-thru and guard-ring constitute the high impedance circuitry of the CD V-720-3. Any accumulation of dirt or grease on these parts will render the instrument inoperable. These parts must not be handled except in accordance with instructions in Section 1 of this Manual.

Electrometer Tube

When checking for a possible open filament of the electrometer tube, use an ohmmeter which has an output current of less than 10 ma when used to measure resistances of about 100 ohms. Current in excess of 10 ma may destroy the filament. No damage will result from use of the ohmmeters described in Appendix B.

Ionization Chamber

The beta window of the chamber is a thin stainless steel disc. If the window should be punctured, the seal of the chamber is destroyed and the readings are no longer independent of altitude, temperature, and humidity. Keep the beta shield closed when servicing the instrument.

The ionization chamber on certain units may be painted yellow. The paint used is entirely free of metallic substances. Repainting is not recommended except according to instructions in the Ionization Chamber portion of Section 1.

Mounting Screws

The screws used to hold the chamber bracket and the shield box to the case top are short and may break off if overtightened. Tighten the screws only until the parts are held securely.

Disassembly Instructions

1. Open the pull catches at the ends of the case and remove the instrument from the case bottom. Lift straight up.
2. Remove the batteries if installed in the instrument.
3. Remove the four screws and centering spacers from the bracket holding the ion chamber assembly to the case top. The ion chamber assembly is electrically connected to the instrument with two wires.
4. Remove the four screws holding the shield box to the case top. Note that one of the screws has a grounding lug that must be reconnected during reassembly. Lift the shield box up and back to gain access to the switch and components on the printed circuit board. (See figure 13-3)
5. Remove the knobs from the range switch and zero control by loosening the set screws in the knobs.
6. Press down on the two control shafts protruding through the case top to remove the circuit board from the case top.
7. To remove the circuit board completely for better access to components, remove the meter terminal nuts,

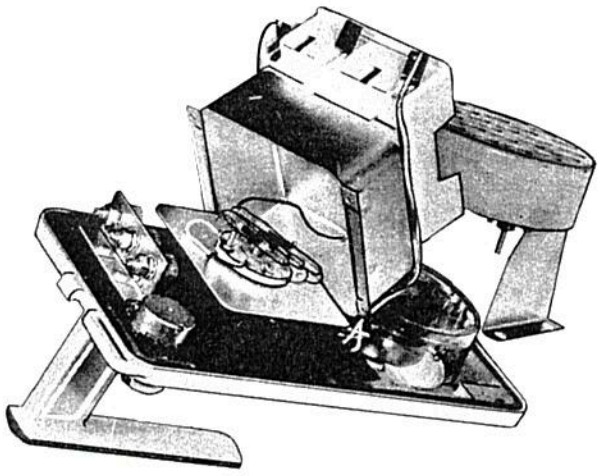


Figure 13-3. Partially Disassembled Instrument

remove the nut holding the lug on the ion chamber, and unsolder the lead to the ion chamber at the high impedance insulator.

Reassembly is the reverse of the above process.

Preventive Maintenance

It is recommended that preventive maintenance procedures be carried out once a month when the instrument is in use and once every six months when the instrument is in storage as follows:

1. Remove the battery; clean the battery contacts and battery terminals if necessary to remove any corrosion present.
2. Replace the battery making certain that the battery makes good contact and exceeds the minimum voltage.
3. Perform the Zero and Circuit Check operations.
4. If the instrument is to be shipped or stored, remove the batteries and set the range switch to one of the sensing ranges. This will shunt the meter and minimize damage from movement of the pointer during shipment or storage.

Do not use cleaning solvents on the plastic parts. Use soap and water to clean the case. If the batteries have leaked, remove the case bottom and fill it with warm water. The battery spillage will be loosened in a short while and can be rinsed out. Dry the case carefully before reassembling. HUMI-SORB desiccant or its equivalent should be packed in the case bottom of the instrument upon receipt at warehouses and upon completion of servicing or periodic maintenance.

Repairs

Electrometer Tube Replacement

The electrometer tube may be replaced without removing the printed circuit board. Disassemble according to the disassembly instructions through step number 4, then:

1. Unsolder the electrometer tube grid lead from the ceramic switch wafer.
2. Carefully push the electrometer tube clamp away from the tube. Do not remove the clamp unless necessary.

3. Remove the tube by unplugging from the socket. Use tweezers or needle-nosed pliers as shown in figure 13-4.

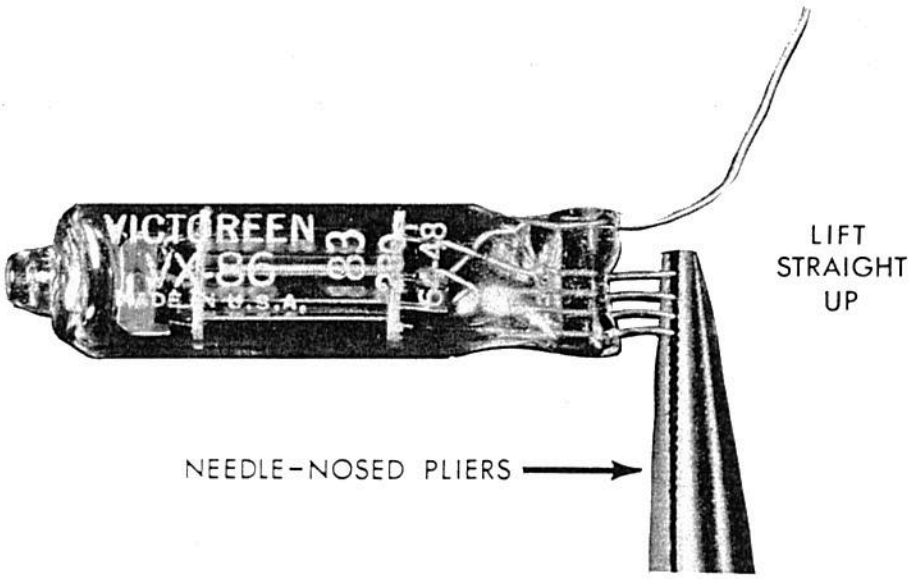


Figure 13-4. Electrometer Tube Removal

4. Remove the sleeving from the grid lead.
5. Cut the leads on the new tube to the same length as on the old tube and install the grid lead sleeving.
6. Insert the tube leads into the socket as before.
7. Reposition the electrometer tube hold down clamp.
8. Resolder the grid lead to the switch.

Switch Replacement

1. Remove the two nuts and washers and unsolder the four leads from the ceramic wafer. Set the ceramic wafer aside.
2. Remove the washers, spacers, and metal shield.
3. Unsolder the eight leads from the phenolic switch wafer. The wafer may now be removed for repair or replacement.
4. Reassembly is the reverse of the disassembly procedure.

Trouble Shooting

The information in this section is presented as an aid to the service technician in determining the causes of specific instrument faults. The Trouble Shooting Guide lists the most probable causes of instrument failure together with suggestions for corrective action. This should be consulted and followed after the following preliminary steps have been taken:

1. Disassemble the instrument through step 6 of the Disassembly Instructions.
2. Check all batteries. Make sure they provide sufficient voltage for proper operation of the instrument.
3. Check the printed circuit board for broken foil, cold solder joints, or solder bridges.
4. Check for broken components.

Table 13-2, Test Point Chart, and figure 13-5, Location of Test Points, eliminate the need for circuit tracing when making voltage and resistance measurements. The Test Points are referred to in the NOTES column of the Trouble Shooting Guide, and are also found on the schematic circuit diagram.

TROUBLE SHOOTING GUIDE

RANGE SWITCH POSITION	SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	NOTES
ZERO	Dead	Poor connection to battery	Repair connection	
		Meter defective	Repair or replace meter	
	Downscale	V1 filament open or making poor contact with socket	Replace V1 or repair connection	Check resistance at A - E
		Battery inserted backwards	Reverse battery	
		Chamber shorting to ground	Reposition insulators	
		Terminals on S1A or S1B shorting to ground	Reposition switch contacts	
		Open contact on S1A	Repair switch	Check continuity at B - D
		Open contact on S1B	Repair switch	Check continuity at K - E K - L

RANGE SWITCH POSITION	SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	NOTES
ZERO (cont'd)	Upscale	Poor connection to battery	Repair connection	
		S1B defective	Repair switch	Check continuity at K - E K - L
		V1 defective	Replace V1	Check V1 for shorts
		R12 defective	Replace R12	
	Erratic	Meter defective	Repair or replace meter	
		Open contact on S1B	Repair switch	Check continuity at K - E K - L
		Open contact on S1C	Repair switch	Check resistances at M - F M - ▲
		R12 defective	Repair or replace R12	
		V1 defective	Replace V1	
CIRCUIT CHECK	Below Red Area	Batteries low or making poor contact	Replace batteries or repair contact	
		Open contact on S1A	Repair switch	Check continuity at B - D
		Open contact on S1C	Repair switch	Check continuity at M - F
		V1 transconductance low	Replace V1	

Radiation Sensing Ranges	Upscale on one or more ranges but greatest effect on X1 range	Moisture contaminating high impedance components	Dry out with heat (150°F or less) or desiccant	
		Chamber defective	Repair or replace chamber	Remove chamber and check instrument again
		V1 defective	Replace V1	Check V1 for grid current
	Pegs upscale on all ranges	V1 defective	Replace V1	Check V1 for shorts
	No response to radiation on all ranges	Chamber defective	Replace chamber	
		Chamber wire broken	Repair connection	
		V1 defective	Replace V1	Check V1 for transconductance
		S1C defective	Repair switch	Check resistances at M-▲ M-F
	Low response to radiation on all ranges	Chamber defective	Repair or replace chamber	
		V1 defective	Replace V1	Check V1 for transconductance
	No response to radiation on only one range	Calibration control turned fully counterclockwise	Recalibrate on particular range	
		High megohm resistor dirty or defective	Clean or replace high megohm resistor	Check resistances at M-

RANGE SWITCH POSITION	SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	NOTES
Radiation Sensing Ranges (cont'd)	No response to radiation on only one range (cont'd)	S1C defective	Repair switch	Check resistances at M - ▲
	Low response to radiation on only one range	Calibration disturbed	Recalibrate on particular range	
		High megohm resistor dirty or defective	Clean or replace high megohm resistor	Check resistances at M - ▲
	Erratic response to radiation	Dirt on ceramic switch wafer	Clean switch	
		Chamber defective	Replace chamber	
		Meter defective	Repair or replace meter	
		S1A defective	Repair switch	Check continuity at K - J K - H K - G
		S1C defective	Repair switch	Check resistances at M - ▲
		V1 defective	Replace V1	

CD

RESISTANCE CHART

Remove batteries before checking resistances. Values ±20% except as noted.

Component	Points	Range Switch Position	Resistance (ohms)
*S1A	B - D	All except OFF	0
	K - G	X100	0
	K - H	X10	0
	K - J	X1	0
*S1B	K - E	All except OFF	0
	K - L	All except OFF	0
S1C	M - F	CIRCUIT CHECK	0
	M - ▲	ZERO	0
	M - ▲	X100	$5 \times 10^{8} \pm 10\%$
	M - ▲	X10	$5 \times 10^{9} \pm 10\%$
	M - ▲	X1	$5 \times 10^{10} \pm 10\%$
*V1 filament	A - E	Any	110

*Remove one meter terminal before making this test.

VOLTAGE CHART

Voltages measured with respect to point ▲ with instrument correctly zeroed on ZERO range. Use a 20,000 ohms per volt meter. All values ±20%.

Point	Voltage	Voltmeter Range
B	22.5	60
C	12.0	60
A	4.25	12
F	1.25	3

Table 13-2. Test Point Chart

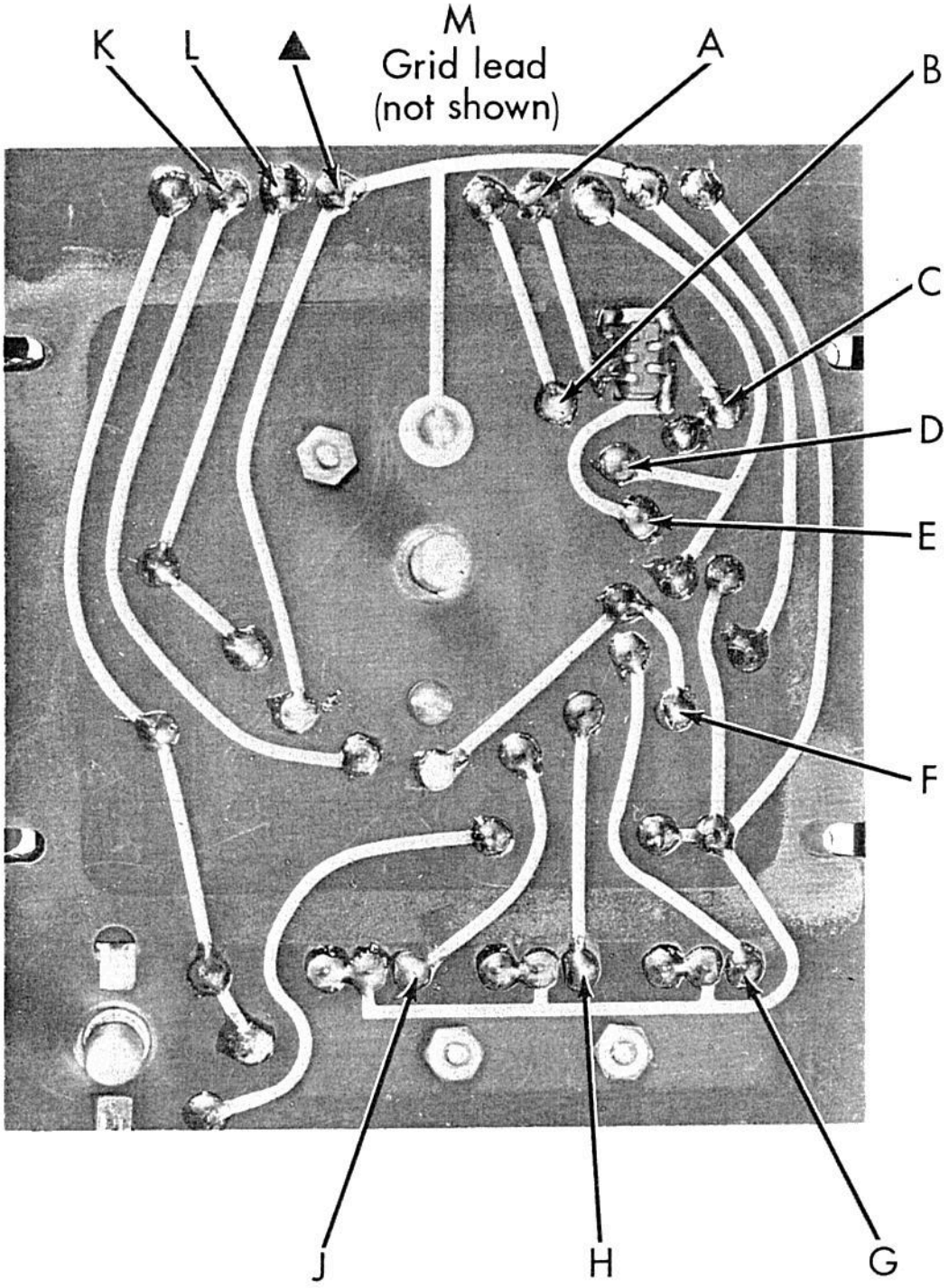
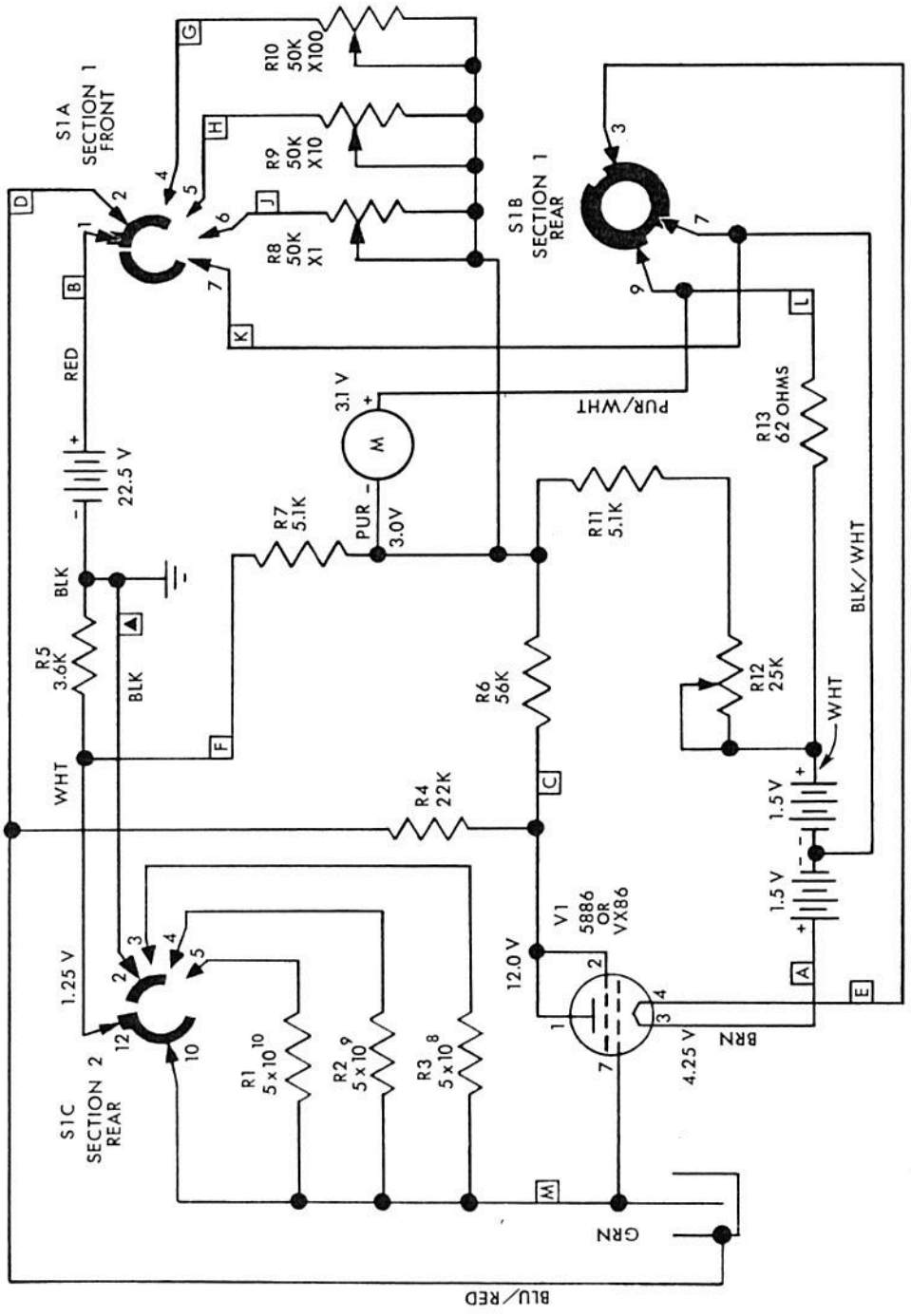


Figure 13-5. Location of Test Points



NOTES:
1. All resistance values in ohms.
2. Switch in CIRCUIT CHECK position.
3. [A] indicates Test Points.
4. Voltages measured with respect to point ▲ with instrument correctly zeroed on ZERO range. Use a 20,000 ohms per volt meter.

Figure 13-6. Schematic Circuit Diagram

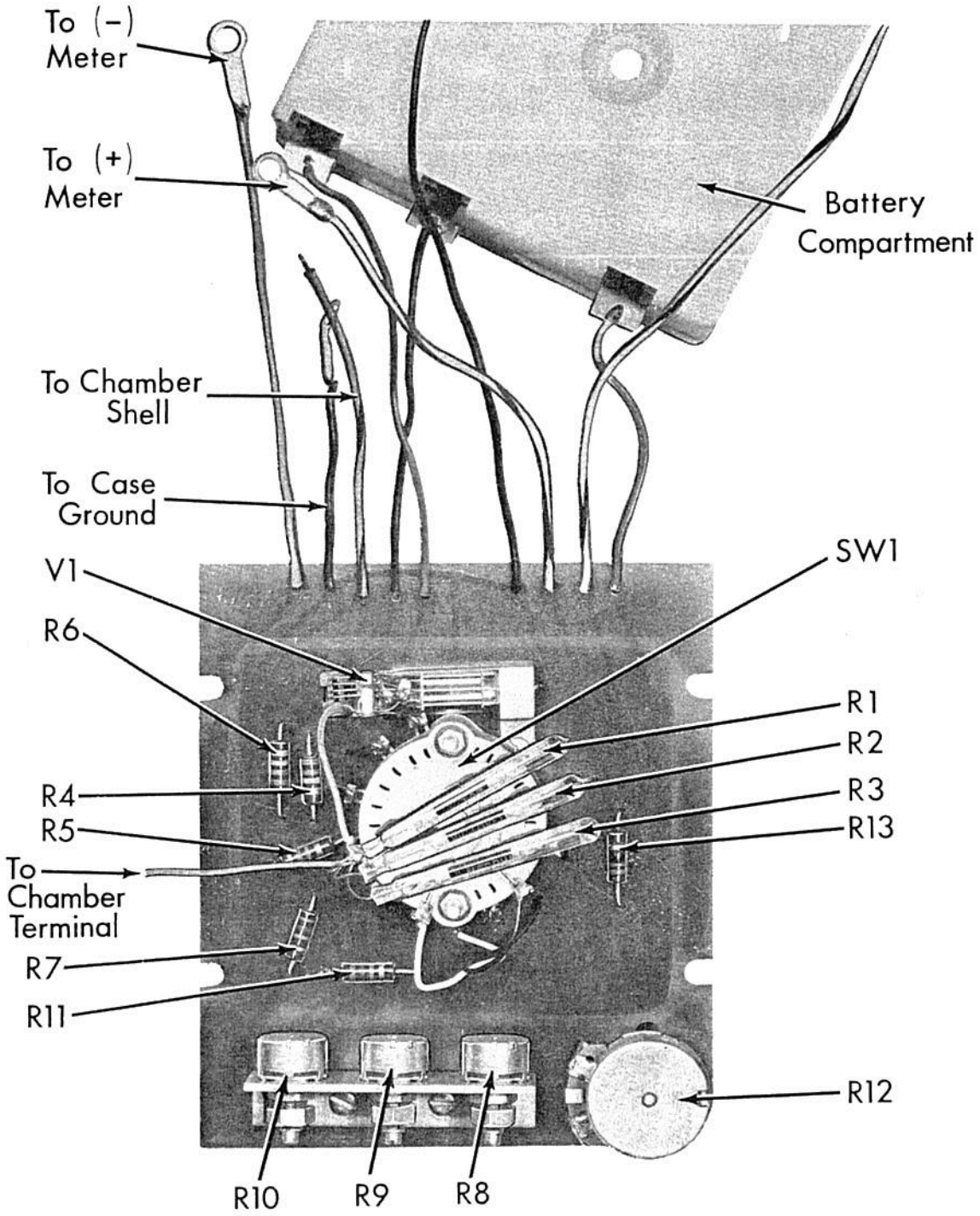


Figure 13-7. Location of Components

PARTS LIST

Electrical Components

Circuit Symbol	Description	Function	Manufacturer & Part No.	LFC Part No.
B1	Battery hearing aid type 22-1/2V NEDA 215	High voltage supply	Union Carbide 412	———
B2	Battery "D" size 1-1/2V NEDA 13	Filament power supply	Union Carbide 950	———
B3	Battery "D" size 1-1/2V NEDA 13	Filament power supply	Union Carbide 950	———
M1	Meter 0-50 ua	Visual indicator	Landers, Frary & Clark 66-2006-021	66-2006-021
R1	Resistor 5×10^{10} ohms ±10%	Chamber load and V1 grid leak (X1 range)	Victoreen Instrument Co.	———
R2	Resistor 5×10^{9} ohms ±10%	Chamber load and V1 grid leak (X10 range)	Victoreen Instrument Co.	———
R3	Resistor 5×10^{8} ohms ±10%	Chamber load and V1 grid leak (X100 range)	Victoreen Instrument Co.	———
R4	Resistor 22K ohms 1/2W	Plate dropping	International Resistance Co. BTS-20	———

Circuit Symbol	Description	Function	Manufacturer & Part No.	LFC Part No.
R5	Resistor 3.5K ohms 1/2W	Dropping resistor	International Resistance Co. BTS-20	———
R6	Resi stor 56K ohms 1/2W	Dropping resistor	International Resistance Co. BTS-20	———
R7	Resistor 5.1K ohms 1/2W	Dropping resistor	International Resistance Co. BTS-20	———
R8	Potentiometer 50K ohms	Calibration adjust X1	Landers, Frary & Clark 66-2006-064	66-2006-064
R9	Potentiometer 50K ohms	Calibration adjust X10	Landers, Frary & Clark 66-2006-064	66-2006-064
R10	Potentiometer 50K ohms	Calibration adjust X100	Landers, Frary & Clark 66-2006-064	66-2006-064
R11	Resistor 5.1K ohm 1/2W	Limiting resistor	International Resistance Co. BTS-20	———
R12	Potentiometer 50K ohms	Zero adjust	Landers, Frary & Clark 66-2006-063	66-2006-063
R13	Resistor 62 ohms 1/2W	Dropping resistor	International Resistance Co. BTS-20	———
SW1	Switch selector assembly	Includes ceramic wafer for chamber load resistors, range section and on-off function	Landers, Frary & Clark 66-2006-027	66-2006-027

Circuit Symbol	Description	Function	Manufacturer & Part No.	LFC Part No.
V1	Electrometer tube	Amplifier	Raytheon Mfg. Co. 5886	———
V2	Ionization chamber assembly	Beta-gamma radiation detector	Landers, Frary & Clark 66-2006-080	66-2006-080

Mechanical Components

Description	Function	Manufacturer & Part No.	LFC Part No.
Battery case assembly	Holds batteries	Landers, Frary & Clark 66-2006-050	66-2006-050
Beta shield assembly	Covers chamber beta window	Landers, Frary & Clark 66-2006-120	66-2006-120
Bracket	Supports calibration potentiometer	Landers, Frary & Clark 66-2006-038	66-2006-038
Bracket	Supports ionization chamber	Landers, Frary & Clark 66-2006-081	66-2006-081
Carrying strap	Shoulder strap	Landers, Frary & Clark 66-2006-087	66-2006-087
Case assembly	Bottom case of instrument	Landers, Frary & Clark 66-2006-010	66-2006-010
Clamp	Holds batteries in	Landers, Frary & Clark 66-2006-053	66-2006-053
Cover assembly	Instrument panel	Landers, Frary & Clark 66-2006-100	66-2006-100
Cover compartment	Shields high impedance components	Landers, Frary & Clark 66-2006-030	66-2006-030
Cover compartment gaskets (2)	Water seal	Landers, Frary & Clark 66-2006-037	66-2006-037

Description	Function	Manufacturer & Part No.	LFC Part No.
Instruction manual (2)	Operating instructions	Landers, Frary & Clark 66-2006-140	66-2006-140
Knob	Range switch knob	Landers, Frary & Clark 66-2006-013	66-2006-013
Knob	Zero adjust knob	Landers, Frary & Clark 66-2006-014	66-2006-014
Knurled nut	Holds battery clamp	General Cement Electronics 8-32	———
Lug #6	———	Zierick Mfg. Corp. SL-6	———
Lug #8 (2)	———	Zierick Mfg. Corp. SL-8	———
"O" ring (2)	Control shaft water seal	Landers, Frary & Clark 66-2006-039	66-2006-039
Printed circuit board	Supports components	Landers, Frary & Clark 66-2006-061	66-2006-061
Shield	———	Landers, Frary & Clark 66-2006-066	66-2006-066
Strap adjuster (2)	Carrying strap length adjustment	Landers, Frary & Clark 66-2006-083	66-2006-083
Strap fastener (2)	Attaches shoulder strap	Landers, Frary & Clark 66-2006-082	66-2006-082

Description	Function	Manufacturer & Part No.	LFC Part No.
Tube clamp	Holds electrometer tube	Landers, Frary & Clark 66-2006-033	66-2006-033
Tube socket	Holds electrometer tube	Elco Mfg. Corp. 788BC	———